UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

**Memorandum**

**SUBJECT:** Asparagus Benefits Assessment for Disulfoton

**FROM:** Nikhil Mallampalli, Ph.D, Entomologist
Herbicide and Insecticide Branch

Colwell Cook, Ph.D, Entomologist
Herbicide and Insecticide Branch

Anthony Gilbert, Economist
Economic Analysis Branch
Biological and Economic Analysis Division (7503C)

**THROUGH:** David Brassard, Ph.D., Senior Scientist
Arnet Jones, Ph.D., Branch Chief
Herbicide and Insecticide Branch
Biological and Economic Analysis Division (7503C)

**TO:** Christina Scheltema, Chemical Review Manager
Betty Shackleford, Branch Chief
Reregistration Branch 3
Special Review and Reregistration Division (7508C)

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***Summary of Analysis***

Disulfoton is a critical pest management tool for asparagus growers in the primary production regions of the country. These regions lie in the Pacific northwest and California, and face large economic losses if populations of the European asparagus aphid are not rigorously and immediately controlled. Management of this insect pest is the primary reason for disulfoton use in this crop. Human health risk modeling suggests that the liquid form of disulfoton may pose risks to mixers, loaders, and applicators. However, all the disulfoton used in the U.S. asparagus crop is applied in liquid form, either aerially or by ground spray rigs. Thus, eliminating these methods of application is likely to result in significant negative impacts on asparagus production in the western U.S. The following analysis provides an overview of U.S. asparagus production, the role of disulfoton in asparagus production, a description of

available alternatives to disulfoton, and estimates of the impacts of eliminating aerial application and/or the liquid forms of disulfoton in this crop.

***Overview***

Disulfoton is an organophosphate insecticide used on a wide variety of crops in part because it not only has contact toxicity but is also taken up by plant root systems and remains active against target insects for a relatively long time. HED risk modeling indicates that the liquid form of this chemical may pose hazards to mixer/loaders and applicators (calculated MOE = 1-35) in asparagus. Therefore, SRRD has asked BEAD to investigate the importance of liquid disulfoton in U.S. asparagus production and the impacts created by restrictions on using the liquid form of this chemical. Re-entry and pre-harvest intervals are not being considered for regulatory action at this time.

Asparagus, *Asparagus officinalis*, is a perennial row crop grown primarily in Washington and California, which together account for about 83% of U.S. production of this vegetable. Michigan accounts for approximately 13%, while the rest of the crop is grown in Arizona, Idaho, Illinois, Maryland, Minnesota, New Jersey, and Oregon [7]. Asparagus requires well-drained, heavier soil with a relatively alkaline pH, and does best in climates where periods of either cold or drought regularly occur. These periods stimulate dormancy in the plants, and this in turn subsequently produces more vigorous vegetative growth of the plants, and thus higher yields. These conditions are best provided in the mid-western and northwestern parts of the U.S. A total of approximately 76,000 acres of asparagus were grown in the U.S. in 1999 [7] . While asparagus can be planted either with seeds, transplants, or crowns, the most common method is to establish fields is to plant one-year old crowns. Crops are harvested no earlier than the second year after planting, so as to allow plants to undergo more vigorous growth. Harvesting of asparagus spears generally begins in mid-January in the western U.S. and in early spring in the mid-west and east coast areas, and continues through June. Virtually all harvesting is done by hand, on a repetitive basis, every one to five days during the early part of each growing season. This harvesting activity lasts one to two months, depending on the size and productivity of fields. After harvest, remaining spears are allowed to grow out into “ferns” (vegetative growth), during which little to no human presence is required in fields [1, 6].

*Pest insect biology*

In asparagus, disulfoton is used primarily to control the European asparagus aphid, *Brachycorynella* ( = *Brachycolus*) *asparagi,* an insect specialized to feed only on this plant. *B*. *asparagi* was accidentally introduced from Europe in the early 1920s and is a serious pest of this crop in Washington, Oregon and California [1, 6]. It is brought into fields primarily via infested crown brought in from nurseries. Once in fields, aphids overwinter as eggs in old fern debris and cracks in the soil. All life stages occur on edible varieties of asparagus. Eggs hatch in the spring and nymphs crawl onto asparagus spears as they emerge from the soil. During most of the crop’s growing season, aphids exist as nymphs, feeding and reproducing asexually. Aphid populations tend to build up under conditions of low rainfall or humidity. Major damage to plants occurs from a toxin injected by aphids during feeding. This toxin causes bushy, stunted, and bluish-green growth. This in turn reduces the number of viable spears, due to dessication of the developing crowns. The toxin itself can also cause a delay in bud break and a profusion of small, less valuable spears [1, 6]. Even low populations of this aphid can cause total losses in an asparagus field, and growers often have no choice but to plow out the field and plant again [1, 4, 5]. Other aphid species, including the green peach aphid, and the bean, melon, and potato aphids, can also become problems on asparagus if left uncontrolled, but disulfoton use is thought to keep these pests rare [1, 3].

***Role of disulfoton in asparagus production***

During 1987-1998, a weighted average of 37,000 lb of disulfoton (active ingredient) were applied on asparagus nationwide; of this 96 % was used in California and Washington. The granular form of disulfoton is currently not registered for use on asparagus, [10] so all of these applications may reasonably be considered to be of the liquid form. Virtually all of this use was targeted against the asparagus aphid [1, 3, 4].

In California, Washington, and Oregon, disulfoton is applied using both ground-boom or aerial methods. However, in all these regions, aerial applications are by far the more common. In 1999, 65 % of applications in California were aerial [2]. In California, closed mixing/loading systems are required, but this is not the case in other states where disulfoton is registered for use on asparagus. In Washington and Oregon, an estimated 98 % of applications are aerial [3]. As a result, most of the disulfoton use in these primary asparagus producing areas is in the liquid form. The chemical is applied 1-2 times per year, almost always during the "fern" stage, when virtually no human presence in fields is required. Aerial application is dictated by the mat-like growth of asparagus in the fern stage, which must be optimized to ensure good harvests the following season, and by the need to keep the crop well irrigated, which makes the soil wet and unstable. These factors often make the use of ground application equipment impossible, due to the difficulty involved in moving it about and the risk of significantly damaging ferns [3, 4].

Asparagus farm sizes tend to be larger in California as compared to other regions of the western U.S. production areas. In 1997, 48 % of asparagus farms in California had 100 acres or more of the crop; on average, these farms had 431 acres grown. Overall average farm size was 219 acres [8]. In Washington, no farms are greater than 300 acres; average size was 62 acres [9]. The maximum area treated in a day by an aerial applicator has been estimated to be about 75 to 150 acres in Washington, and 150 to 200 acres in California [3, 4]. These estimates were based (by the crop experts contacted) on discussions with aerial applicators in their respective states. This is partly a result of the fact that, even on larger farms, asparagus fields are interspersed with other crops, and applicators do not typically treat all the acreage of a given grower at any one time [3, 4] .

*Chemical alternatives*

For aphid control in asparagus, chlorpyrifos is the only currently registered chemical control alternative available in California. It is also available in Washington, and Oregon, where dimethoate is also an option in this context. Both these insecticides have significant drawbacks in this cropping system, however. Chlorpyrifos is not as effective as disulfoton in eliminating asparagus aphids from fields due to a short residual effect, and may cause outbreaks of other aphid species [1, 3]. Dimethoate also has a very short residual effect (1 day) and thus is also not as good as disulfoton [3]. Biological control agents such as ladybeetles and parasitic wasps occur, but cannot usually keep up with aphid infestations in the western growing regions [3, 4].

***Impact of restricting disulfoton use in asparagus***

Curtailing aerial or liquid application of disulfoton will be effectively equivalent to eliminating this pesticide in asparagus, since ground application is so difficult and the granular form is not an option

for control of the target pest. Given the damage inflicted by the asparagus aphid, this can be expected to result in substantial economic losses to growers in Washington and California. Yearly per acre economic losses in Washington could exceed $700 if disulfoton were eliminated and growers were forced to rely on the other available chemical alternatives (chlorpyrifos and dimethoate). This would translate into aggregate losses to asparagus growers of about $273,000 per year. In California, per acre economic losses could exceed $1000 per season with an aggregate loss to growers of approximately $166,000 per year. This analysis corroborates the results of an earlier study, conducted by Washington State University in 1997. It estimated aggregate losses to the asparagus industry in these states of about $38,000,000 per year, about 40% of gross farm-level (preprocessing level) revenue [(1)]. That study was based on chlorpyrifos and malathion as the chemical alternatives available. The authors estimated that this would end west coast asparagus production in four years at most.

***Sources and References***


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